

## **APPLICATION OF CMC MATERIALS INTO AERO-ENGINES**

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IHI is one of the oldest companies in Japan. It started in 1853 as a shipbuilding company, but it has produced aero-engines since 1957. At an early stage in aero-engine business, IHI was producing military engines mainly. But IHI participated in commercial engine business in 1980's as a partner of international joint development team. Since then, business scale has grown to 4 billion dollars of annular sales.

It is expected that aero-engine market continues to grow by 4 to 5% per year. However, there are several problems to solve such as environmental regulation tightening, restriction in number of aircraft departure and landing on airport and increase in number of low cost carriers with financially weakness. In order to solve these problems, aero-engines have to evolve into system with lower fuel burn, more environmental suitability, larger thrust and lower lifecycle cost. There are several candidates to solve the problems, but it is certain that application of lighter and higher temperature resistant materials is one of solutions.

We introduce our products and R&D activities for composite material technologies as a solution for the above-mentioned problems. The composite material technology means not only material but also design and manufacturing. IHI concentrates on light CFRP for fan module and light and heat resistant CMC for turbine module in aero-engines. Regarding CFRP, we have both of thermoset type and thermo-plastic type. The former was applied into fan case and the latter into fan structural guide vane. They became products supplied with PW1100G engine for Airbus A320neo. On the other hand, CMC technology is under development for military and commercial engines. Our CMC manufacturing process is as follows. SiC fibers are processed on BN interface coating. BN coated fibers are weaved into 3D woven fabric. CVI, PIP and SPI process infiltrate matrix into 3D woven fabric. SPI is solid particle infiltration. After that, it is machined and finally EBC coated. Positive feature of our material is superiority in heat and impact resistance. Technology validation was conducted on in-house small gas turbine named IM270 for electric power generation. Next validation test will be conducted on a two-shaft turbo-fan aero-engine to be introduced to JAXA in a few years. CMC technology development has been supported by government funding from METI, NEDO, SIP and JAXA.